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EXAMINER

NGUYEN, NGOC YEN M

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1793

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ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

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DETAILED ACTION

The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

Claims 27-28 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention.

There is no sufficient support in the instant specification for the product mixture "comprises HCl and HSiCl₃". It should be noted that in the instant claims, the "comprises" or "comprising" does not exclude the presence of silicon, and as evidenced by DeLuca (5,910,295), silicon tetrachloride can be converted into trichlorosilane without forming hydrochloric acid (note reaction 1 in column 1). From the reactions 1-4 in DeLuca '295, the hydrogen and chlorine are merely carriers (note column 1, lines 35-44).

The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 1-17, 19-23, 26-30 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

In claim 1, step (b) further requires “passing the product mixture from the heating as a starting material to a direct further use”, this step would use the trichlorosilane (HSiCl_3) produced in the heating step to produce other products, such as alkylsilanes, organochlorosilanes, monosilane or silicon or silica (note for example, the instant specification, page 6, lines 5-9). Thus, when step b) is positively required, this step does not further limit the “process for the catalytic hydrodehalogenation of SiCl_4 to HSiCl_3 ” because the final product, after step b), would no longer be the HSiCl_3 .

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 1-3, 5, 14-15, 17, 21-22, 27, 29-30 are rejected under 35 U.S.C. 102(b) as being anticipated by Yamanaka et al (6,653,212) with DeLuca (5,910,295) or Rodgers et al (3,933,985) to show inherent state of fact.

Yamanaka '212 discloses a process for forming a thin film on a substrate in a vacuum chamber by catalytic CVD or high density plasma CVD or high density catalytic CVD, comprising:

a cleaning step of feed a carrier gas containing hydrogen to the vacuum chamber and cleaning the top of the substrate by activated hydrogen H^* generated in the fed carrier gas, and

a thin film forming step of forming the thin film on the substrate by feeding a material gas to the vacuum chamber (note claim 30).

The substrate can be silicon (note claim 61).

The thermal catalyst contains at least one type of material selected from a group consisting of tungsten, tungsten containing thoria, platinum, molybdenum, palladium, tantalum, etc. (note claim 49). The thermal catalyst is heated to 800-1700°C (note column 33, lines 14-16). The thermal catalyst can be a coil or other shapes such as wire, grid (note paragraph bridging columns 43-44).

The thin film can be a polycrystalline silicon, single crystalline silicon, amorphous silicon, microcrystalline silicon, etc. (note claim 56). The polycrystalline silicon and single crystalline silicon film are formed by a gas containing hydrogen as the carrier gas and containing at least one of monosilane, disilane and trisilane as the material gas (note claim 59). Yamanaka '212 further teaches that beside the material gas as stated above, silicon tetrachloride can be used (note column 48, lines 53-54).

When the substrate is silicon, with hydrogen as carrier gas and silicon tetrachloride as the material gas in the process of Yamanaka '212, trichlorosilane is formed, as evidenced by DeLuca '295 (note column 1, lines 31-44, especially reaction 1).

Alternatively, Yamanaka '212 teaches that catalytic CVD is a method for activating and ionizing at least one part of a material by a catalytic reaction or a thermal decomposition reaction for the thermal catalyst heated to less than the melting and depositing these deposition seeds on a heated substrate (note column 9, lines 12-16). The thin film is formed on the surface of the substrate by utilizing a thermal decomposition reaction and/or catalytic reaction by the thermal catalyst (note column 26, lines 9-12). When monosilane is used as the material gas, thin film is deposited by catalytic decomposition (note column 42, lines 22-26), however, the teaching of Yamanaka '212 is not limited to just the decomposition of monosilane. When other material gas is used, such as silicon tetrachloride, in the presence of hydrogen, the silicon thin film would be deposited by a catalytic *reaction* as evidenced by Rodgers '985 (note reactions 1 and 2 in column 3 and Example 1), i.e. the silicon tetrachloride would react with hydrogen to first form trichlorosilane (faster reaction) before the trichlorosilane would further react with hydrogen to form silicon and HCl, hydrogen, and silicon tetrachloride with unreacted trichlorosilane (note reaction in column 1, lines 36-40).

In any event, the process of Yamanaka '212 has all the positive process steps as required in the instant claims, i.e. bringing a gaseous feed mixture comprising hydrogen and silicon tetrachloride into direct contact with a heating element and heating the gaseous feed mixture by contacting the gaseous feed mixture with the heating element, at least some HSiCl_3 would inherently be formed as an intermediate product. This intermediate product would further be used to form the silicon film, as required in step

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(b) of the instant claim 1, as disclosed in Yamanaka '212. Again, DeLuca '295 or Rodgers '985 can be used to show the inherent state of fact that HSiCl_3 reacts with hydrogen to form Si.

It should be noted that in Yamanaka '212, as carrier gas, "preferably use is made of an inert gas such as He, H_2 , Ar, or N_2 " (note column 48, lines 53-54), the "inert gas" is preferred but not a must.

Yamanaka '212 further teaches that by feeding hydrogen as the carrier gas, heating the thermal catalyst to a state enabling a catalytic action, and continuously forming at least the silicon film and the gate insulating film, a slow stress and low contamination can be achieved in the gate channel portion (note column 13, lines 20-24).

The process of Yamanaka '212 anticipates the claimed process.

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 1-11, 13-17, 19-23, 27, 29-33 are rejected under 35 U.S.C. 103(a) as being unpatentable over Yamanaka '212 with DeLuca '295 or Rodgers '985 to show inherent state of fact.

Yamanaka '212 discloses a process as stated above. DeLuca '295 or Rodgers '985 is applied to teach that trichlorosilane is inherently formed as an intermediate product in the process of Yamanaka '212.

In the event the number of embodiments in Yamanaka '212 is too large for anticipation, it would have been obvious for one of ordinary skill to select any combinations among the embodiments disclosed in Yamanaka '212.

Yamanaka '212 discloses that the substrate temperature can be about 300-400°C or about 800-1000°C (note column 51, lines 9-13 and lines 21-22) and the thermal catalyst is heated to 800-1700°C (note column 33, lines 14-16). These three ranges fairly suggest that the gaseous feed mixture is contact with the heating element at a temperature in any of these three ranges.

For overlapping ranges, with respect to the encompassing and overlapping ranges previously discussed, the subject matter as a whole would have been obvious to one of ordinary skill in the art at the time of invention to select the portion of the prior art's range which is within the range of the applicants' claims because it has been held prima facie case of obviousness to select a value in a known range by optimization for the results. *In re Boesch*, 205 USPQ 215. Additionally, the subject matter as a whole would have been obvious to one of ordinary skill in the art at the time invention was made to have selected the overlapping portion of the range disclosed by the reference because overlapping ranges have been held to be a prima facie case of obviousness. *In re Malagari*, 182 USPQ 549.

Yamanaka '212 discloses that the power supply in the example is a DC power supply or an AC power supply or a power supply wherein the AC is superposed on the DC and is selected in accordance with the situation. By adjusting the voltage and/or current of the power supply, it becomes possible to adjust the temperature of the thermal catalyst (note column 45, lines 1-10) and it would have been obvious to one skilled in the art to optimize the temperature of the thermal catalyst to provide the best results.

In the process of Yamanaka '212, it would have been obvious to one of ordinary skill in the art to optimize the space velocity, the molar ratio of hydrogen and silicon tetrachloride, the pressure for the process in order to obtain the best results.

For the construction material for the reactor of Yamanaka '212, it would have been within the skill of the artisan to select a construction material for the reactor that can withstand the reaction conditions.

For claim 32, the "gaseous mixture consisting of hydrogen and silicon tetrachloride" does not exclude the presence of a solid substrate in the process of Yamanaka '212. For the step of forming polycrystalline silicon film, only hydrogen and a silicon containing gas are used, in this instant, monosilane is used (note for example, column 52, lines 20-35). It should be noted that SiCl_4 can be used instead of monosilane (note column 48, lines 53-54).

Claims 1-17, 19-23, 26-30 are rejected under 35 U.S.C. 103(a) as being unpatentable over JP 57-118017 in view of Yamanaka et al (6,653,212) and Roewer et al (5,716,590), further in view of Rodgers (3,933,985).

JP '017 discloses a process for producing SiHCl_3 in high yield. In the process, SiCl_4 is mixed with H_2 in 4:1 to 1:10 molar ratio and introduced into the first reactor B, and by electrifying a graphite resistance 1, the interior of the reactor B is heated to 500-1,300°C to produce SiHCl_3 as well as HCl by-product in the presence of catalyst 9 (note English abstract). In JP '017, any unreacted reactants can be transferred to the second reactor to further produce SiHCl_3 and this step can be deleted along with its function, In re Wilson 153 USPQ 740 (CCPA 1967).

The SiCl_4 to H_2 ratio as disclosed in JP '017 overlaps the claimed range. With respect to the encompassing and overlapping ranges previously discussed, the subject matter as a whole would have been obvious to one of ordinary skill in the art at the time of invention to select the portion of the prior art's range which is within the range of the applicants' claims because it has been held prima facie case of obviousness to select a value in a known range by optimization for the results. *In re Boesch*, 205 USPQ 215. Additionally, the subject matter as a whole would have been obvious to one of ordinary skill in the art at the time invention was made to have selected the overlapping portion of the range disclosed by the reference because overlapping ranges have been held to be a prima facie case of obviousness. *In re Malagari*, 182 USPQ 549.

For the pressure, space velocity for the reaction, it would have been obvious to one of ordinary skill in the art to optimize these conditions through routine experimentation in order to obtain the best results.

For the construction material for the reactor of JP '017, it would have been within the skill of the artisan to select a construction material for the reactor that can withstand the reaction conditions.

The differences are JP '017 does not disclose (1) the use of a metal heating element (the heating element in JP '017 is a graphite resistance) that can serve as a catalyst (the catalyst in JP '017 is carbon) and (2) the fractionating or at least condensing the product mixture (step (a)) or passing the product stream to a direct further use (step (b)).

For difference (1), Roewer '590 discloses a process for catalytic hydrodehalogenation of a halogen containing compound of carbon or silicon by contacting said compound in the presence of hydrogen with a catalytically active material comprising (1) elemental silicon and at least one transition metal or comprising (2) a transition metal silicide, at a temperature sufficient to induce catalytic hydrodehalogenation (note claim 1). The transition metal is preferred to be nickel, copper, iron, cobalt, molybdenum, palladium, platinum, etc. (note column 5, lines 23-37). Roewer '590 discloses a process for producing trichlorosilane (SiHCl_3) from silicon tetrachloride (SiCl_4) using the catalyst as mentioned above in Example 4.

It would have been obvious to one of ordinary skill in the art to use the catalytically active material as suggested by Roewer '590 as the catalyst in the process

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of JP '017 because such catalytically active material is analogous to the catalyst used in JP '017.

Yamanaka '212 discloses a thin film forming apparatus comprising a vacuum chamber, a substrate, a thermal catalyst, and a heating means for heating the thermal catalyst, wherein a gas introduction system for introducing a gas is connected to the vacuum chamber and wherein the gas is fed from the gas introduction system into the vacuum chamber to form a thin film on a surface of the substrate by utilizing a thermal decomposition reaction and a catalytic reaction by the thermal catalyst, the gas introduction system introduces a carrier gas containing hydrogen and a material gas for forming the thin film on the substrate, and the apparatus comprises a means for raising a concentration of the material gas in the vacuum chamber in the middle of the formation of the thin film on the substrate (note claim 1).

The thermal catalyst contains at least one type of material selected from a group consisting of tungsten, tungsten containing thoria, platinum, molybdenum, palladium, tantalum, metal deposited ceramics, silicon, alumina, silicon carbide, refractory metals (tungsten, tantalum, tungsten containing thoria, molybdenum, titanium, etc.) coated with silicon carbide or ceramics or conductive nitride films, silicon nitride or oxide, conductive metal nitrides (tungsten nitride, titanium nitride, molybdenum nitride, tantalum nitride, etc.), boronitride (BN), and silicide (note claim 24). The "at least one" fairly suggests a combination of two or more of the above listed compounds can be used, such as a combination of silicon and a metal, and this combination is similar to the catalytically active material disclosed in Roewer '590.

The thermal catalyst is preferred to be a wire made of tungsten, palladium, tantalum or molybdenum (note column 32, lines 63-65). The thermal catalyst 5 is not limited to one formed into a coil as shown in Figures 1-3. It is also possible to form it into a grid as shown in FIG. 6. The grid-like thermal catalyst is formed by for example assembling a plurality of wires having predetermined lengths in a grid and joining assembly portions of the wires by welding or the like. Further, it is also possible to form the thermal catalyst by winding a wire, coil, or the like of the thermal catalyst one or more times around a high heat resistant insulator such as ceramics, and quartz glass. Alternatively, it is also possible to press it to a flat metal plate to form the grid (note paragraph bridging column 43-44). The power supply in the present example is a DC power supply or an AC power supply or a power supply wherein the AC is superposed on the DC and is selected in accordance with the situation. By adjusting the voltage and/or current of the power supply, it becomes possible to adjust the temperature of the thermal catalysts (note column 45, lines 1-10).

Yamanaka '212 also discloses that the apparatus can be used to produce a film of Si and Poly-Si, produced from SiH_4 , SiHCl_3 , SiCl_4 , etc. (note column 48, lines 52-54).

Thus, Yamanaka '212 fairly teaches that the thermal catalyst can be safely used in an atmosphere containing SiCl_4 , SiHCl_3 and H_2 .

For the combined teaching of JP '017, Roewer '590 and Yamanaka '212, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use the thermal catalyst, as suggest by Yamanaka '212, which comprises a silicide or a mixture of silicon and a metal, for heating the reactor in the process of JP '017

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because such thermal catalyst can serve as both the heating element and the catalytically active material, as suggested by Roewer '590.

Rodgers '985 can be applied to teach that when SiCl_4 is used to produce Si (as desired in the process of Yamanaka '212), the reaction between SiCl_4 and hydrogen is too slow, so the SiCl_4 normally reacts with hydrogen to form SiHCl_3 first then the SiHCl_3 is subsequently converted to Si.

Thus, Rodgers '985 fairly suggests that when SiCl_4 is used as the starting reactant in Yamanaka '212, the thermal catalyst in Yamanaka '212 may serve as a catalyst to promote the formation of SiHCl_3 from SiCl_4 first, before the SiHCl_3 is converted to Si film.

For difference (2), JP '017 discloses that in the second reactor, the mixed gas containing the residual unreacted SiCl_4 and H_2 is cooled and passed through a fixed metallic Si bed, the HCl is converted into SiHCl_3 by a reaction with the metallic Si. The resulting mixed gas of H_2 , SiCl_4 and SiHCl_3 is taken out of the exhaust port, and the SiHCl_3 is separated and collected (note English abstract).

JP '017 does not specifically disclose how the SiHCl_3 is separated.

Rodgers '985 discloses that after a mixture of hydrogen and silicon tetrachloride is passed through a furnace reactor unit at suitable rates and temperatures to convert a portion of the silicon tetrachloride to trichlorosilane, the reaction products from the furnace are passed through a pre-cooler to lower the temperature of the products to approximately room temperature and the room temperature gases are then passed through a condenser unit to separate the hydrogen and hydrochloric acid reaction

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products from the silicon tetrachloride and chlorosilane liquid products. The hydrogen gas and the hydrochloric acid gaseous products are directed through a water scrubber which separates the hydrochloric acid from the hydrogen and the hydrogen gas after suitable drying can be reused as the hydrogen source. The liquid mixture of silicon tetrachloride and trichlorosilane is passed through a distilling unit which separates the trichlorosilane product from the silicon tetrachloride which later can be recycled (note paragraph bridging columns 2-3).

For the combined teaching of JP '017 and Rodgers '985, when the second step as disclosed in JP '017 is omitted, it would have been obvious to one skilled in the art to separate the mixed gas obtained from the first reactor (reactor "B" in Figure 3) into the product stream SiHCl_3 , the unreacted SiCl_4 stream, and the H_2 and by-product HCl stream as suggested by Rodgers '095 (note Figure 1).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to separate the hydrogen from the silicon tetrachloride and the trichlorosilane in the process of JP '017 by condensing method and to separate the silicon tetrachloride from the trichlorosilane by distilling method (which is considered the same as the claimed "fractionating") as suggested by Rodgers '985 in order to recover hydrogen and silicon tetrachloride for recycling purposes.

Rodgers '985 is also applied to teach that after the SiHCl_3 is formed, the SiHCl_3 is fed to a subsequent step to produce Si (note column 1, lines 34-40 and Figures 1-2).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to use the SiHCl_3 produced in the process of JP '017 as the

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reactant to produce Si as suggested by Rodgers '985 because using a product from one reaction as reactant for another reaction is well within the skill of the artisan.

Applicant's arguments filed May 4, 2010 have been fully considered but they are not persuasive.

Applicants argue that Yamanaka explicitly discloses that hydrogen is an inert gas "for the formation of a film of Si and Poly-Si" while the hydrogen in reaction (1) of DeLuca is not inert.

In Yamanaka '212, the catalytic CVD method as disclosed can be either or "catalytic reaction" or a "thermal decomposition" (note for example, column 9, lines 12-16 and column 16, lines 9-13); thus, carrier gas can be inert for "thermal decomposition" and can react for "catalytic reaction". It should be noted that the use of "inert gas" as mentioned in column 48, lines 48-52) is only preferred, not mandatory. Furthermore, it should be noted that "carrier" gas can be different from "inert" gas, i.e. carrier gas can be used in addition to inert gas (note column 25, lines 15-18).

Applicants argue that the processes of Yamanaka '212 and DeLuca '295 are entirely different and contradictory. Yamanaka '212 forms a film of Si and DeLuca reacts silicon metal to form trichlorosilane.

In DeLuca, the trichlorosilane is further used to form Si (note reaction 4). It should be note that the extra steps or reactions to convert trichlorosilane into Si are not excluded by Applicants' claims, note step (b) of Applicants' claim 1 that requires passing the product mixture as a starting material to a direct further use.

Applicants argue that more than one reference was used in the 102 rejections.

As stated in the above rejection, DeLuca or Rodgers is applied to show inherent state of fact, not to modify the process of Yamanaka '212.

Applicants argue that at least 19 and 20 are patentable over any CVD process disclosed in Yamanaka '212.

Claims 19 and 20 are not included in the 102 rejection.

Applicants argue that the Rodgers process discloses that the ratio of silicon tetrachloride and hydrogen should be maintained such that the formation of silicon is avoided.

Granted that it is true, however, Rodgers discloses a 2-step process, in the first step, trichlorosilane is produced and the formation of silicon is avoided in this step as argued by Applicants; however, in the second step, the trichlorosilane is converted into silicon (note Figure 2).

Applicants argue that in new independent claim 32, the reaction mixture forms trichlorosilane in the absence of any silicon metal.

It should be noted that only the "gaseous mixture" has "consisting of" language; however, the process has "comprising of" language that does not exclude the presence of a solid Si substrate.

Applicants argue that Roewer does not disclose a heating element that is made of any of the metals described in the present claims and the catalytically active material in the JP '017 reference is not a heating element.

Granted that it is true, however, as stated in the above rejection, it would have been obvious to use a thermal catalyst as suggested by Yamanaka '212 in the process of JP '017 because it can serve not only as the heating element but also as the catalyst.

Applicants argue that the reaction (1) of DeLuca is not a hydrodehalogenation. Instead, reaction (1) is a "hydrochlorination".

In reaction (1) of DeLuca, SiCl_4 is converted into HSiCl_3 , since hydrogen is introduced and the number of chlorine is reduced (from Cl_4 to Cl_3), the reaction (1) is considered as "hydrodehalogenation" process.

Applicants argue that Rodgers discloses that the reaction of silicon tetrachloride and hydrogen produces a mixture of trichlorosilane and hydrogen chloride.

It should be noted that both DeLuca and Rodgers disclose that SiCl_4 can be converted into trichlorosilane; however, hydrogen chloride is produced in Rodgers but not in DeLuca. Thus, the formation of HCl is not inherently from a "hydrodehalogenation" step, and because Applicants do not explicitly disclose the formation of HCl in the specification, there is no sufficient support for the limitation as required in Applicants' claims 27-28.

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Hiraishi (4,224,061) and Zayets (6,197,436) are cited to show that tungsten, tantalum, etc. are known for their acid corrosion resistance.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Ngoc-Yen M. Nguyen whose telephone number is (571) 272-1356. The examiner can normally be reached on Part time schedule.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Stanley Silverman can be reached on (571) 272-1358. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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/Ngoc-Yen M. Nguyen/
Primary Examiner, Art Unit 1793

nmn
July 20, 2010